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Equilibrium Leadership in Tax Competition Models with Capital Ownership: A Rejoinder

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Equilibrium Leadership in Tax Competition Models with Capital Ownership: A Rejoinder[1]

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Abstract

This paper reconciles two opposite results in the tax competition literature. On one side Kempf and Rota-Graziosi (J.Pub. Econ 94:768-776, 2010) and Hindriks and Nishimura (J. Pub Econ 121:66-68, 2015) have shown that the two Stackelberg outcomes prevail as the subgame perfect equilibria when capital is entirely owned by non-residents. On the other side Ogawa (Int. Tax Pub Fin 20:474-484, 2013) has shown that the simultaneous-move outcome prevails when capital is entirely owned by residents. We develop a model in which capital ownership can vary freely between these two polar cases. We show that there exists a unique degree of residential capital ownership such that the equilibrium switches from the Stackelberg to the simultaneous-move outcomes. The chance for the simultaneous-move outcome to prevail increases with the extent of asymmetry among regions.

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Keywords: Endogenous timing; Tax competition; Capital ownership.

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1 Introduction

The issue of leadership in tax competition models has been extensively studied recently. Using Hamilton and Slutsky's (1990) framework, Kempf and Rota-Graziosi (2010, hereafter K-RG) concluded that the Stackelberg outcomes are the Subgame Perfect Equilibria (SPE) of the timing game. They also showed that leadership by the small region is the risk dominant outcome. Hindriks and Nishimura (2015, hereafter HN) adopted different source of regional heterogeneity, namely the intercepts of the capital demand functions rather than their slopes, to capture the differences of the market power. HN (2015) showed that, contrary to K-RG (2010), leadership by the large region becomes the risk dominant equilibrium and can even become Pareto superior. This discussion was based on the assumption that residents did not own the capital and thus that regions did not internalise the impact of tax choice of the capital owners (absent ownership model).

However the work of Ogawa (2013) demonstrates the importance of regional capital ownership. Indeed considering the case where the capital is fully owned by residents in the regions, he showed that the simultaneous-move outcome prevails as the SPE. Kempf and Rota-Graziosi (2014) also considered that capital is fully owned by residents but not necessarily uniformly across regions (i.e., residents in one region may own more capital than residents in the other region). The unequal distribution of capital ownership is further developed in Kempf and Rota-Graziosi (2015) to verify under which distribution of capital ownership the equilibrium tax leadership still prevails and the leadership by the small region becomes the risk dominant outcome. Our contribution in this paper is to provide a simple rejoinder between the full capital ownership model à la Ogawa (2013) and K-RG (2014) and the no capital ownership à la K-RG (2010) and HN (2015). We will consider that capital ownership can vary between these two polar cases. The difference with the K-RG (2015) is that we assume uniform capital ownership to restrict attention to a single dimension of asymmetry which is the "market power" in which the "large" region is characterized by a higher intercept of its demand for capital. In doing so we provide a unifying framework in which capital is partially owned by the residents and partially by the non-residents. We show that: (i) for low levels of regional capital ownership, the two Stackelberg outcomes prevail as in K-RG (2010, 2014) and the large region leadership is the risk dominant outcome as in HN (2015), (ii) for intermediate levels of regional capital ownership, only the large region's leadership prevails as the unique SPE, and (iii) for high levels of regional capital ownership, only the simultaneous-move outcome prevails as in Ogawa (2013). Therefore, combining cases (i) and (ii), we can extend the HN (2015)'s result of the large region's leadership to partial regional capital ownership. In terms of size effect, we show that the chance of the simultaneous-move equilibrium to prevail increases with the extent of asymmetry among regions.

2 The model and the result

There are two regions, denoted by A (large region) and B (small region).[1] For any amount of capital employed in region i, K_i, the production in region i is given by the function $F_i(K_i) = (a_i - bK_i)K_i$ with $a_A > a_B$. Region A is denoted the "large" region in the sense of facing a higher intercept of its demand of capital. This can be related to a larger market power. HN (2015) and Ogawa (2013) use the same form of production asymmetry whereas in K-RG (2010) the production asymmetry takes the form of different b_i but same a. The total supply of capital $\bar{K}$ is fixed, and the capital is perfectly mobile between regions. To insure interior solution, we assume:

Assumption 1 $\delta \equiv \dfrac{a_A - a_B}{b\bar{K}} \in (0, 4)$.

Region i sets taxes on capital denoted by t_i. The arbitrage and the market clearing conditions involve:

$$F'_A(K_A) - t_A = F'_B(K_B) - t_B = r,\ K_A + K_B = \bar{K},$$

which yield:

$$K_i(t_i, t_j) = \frac{1}{4}\frac{a_i - a_j + t_j - t_i + 2b\bar{K}}{b}\ \ (i, j = A, B,\ j \neq i),\ r = \frac{a_A + a_B - t_A - t_B - 2b\bar{K}}{2},$$

where r is the price of capital which is decreasing in t_i.

Capital is freely distributed between regions depending on the tax rates and the productivity differences. However capital ownership is fixed. Different configurations of capital ownership are possible (θ_A, θ_B). To limit attention on the production asymmetry, we assume uniform ownership configuration so that the fraction of capital owned by residents in each region is $\theta_A = \theta_B = \theta$ with $\theta \in [0, 1/2]$. In that sense, the meaning of "large" region is unambiguously related to market power and not to capital ownership.[2] When

[1] The model used follows K-RG (2010, 2014), Ogawa (2013), and HN (2015). The notations closely follow K-RG (2014) and HN (2015).

[2] K-RG (2015) allowed for a combination of production asymmetry (market power) and ownership asymmetry (financial power). The results they obtain are much less clear cut because of the interplay of the two forms of regional asymmetries. We see their analysis as useful extension of our analysis to account for the presence of small regions with high financial power.

$\theta = 0$, the capital is fully owned by absentee owners (K-RG (2010) and HN (2015)). When $\theta = 1/2$, the capital is fully owned by residents in the regions (Ogawa (2013) and K-RG (2014)).[3]

The welfare function of region i is the following:

$$\begin{aligned} W_i &= F_i(K_i) - K_i F_i'(K_i) + r\theta \bar{K} + t_i K_i \\ &= F_i(K_i) - r(K_i - \theta \bar{K}) \end{aligned}$$

The second equality uses the arbitrage condition $F_i'(K_i) = t_i + r$. Namely, the welfare function is the total output minus the remuneration of capital on the amount of capital that is imported. A country that is a tax exporter will benefit from increasing interest rate and a country that is a capital importer will benefit from lower interest rate. Since the interest rate r decreases with tax, the preferred tax rate is higher for the capital importing country (which is more likely for low θ). As we will see shortly, negative taxes can prevail in equilibrium but only in the "small" region and if the capital ownership θ is sufficiently high.

To derive the equilibrium of the Hamilton-Slutsky's (1990) timing game, we first derive the equilibria of three tax games: (i) Simultaneous game G^N where each region chooses t_i simultaneously and non-cooperatively, (ii) Stackelberg Game G^A where large region A leads in the choice of the tax rates, and (iii) Stackelberg Game G^B where small region B leads.

Let $\Omega \equiv a_A + a_B$. For G^N,

$$\begin{aligned} t_A^N &= b\bar{K}\left(\frac{1}{4}\delta + 1 - 2\theta\right),\ t_B^N = b\bar{K}\left(-\frac{1}{4}\delta + 1 - 2\theta\right), \\ W_A^N &= \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{64}(3\delta + 24 - 16\theta) + \frac{b\bar{K}^2}{4}(8\theta^2 - 12\theta + 3), \\ W_B^N &= \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{64}(3\delta - 24 + 16\theta) + \frac{b\bar{K}^2}{4}(8\theta^2 - 12\theta + 3). \end{aligned} \tag{1}$$

For G^A (large region's leadership),

$$\begin{aligned} t_A^L &= b\bar{K}\left(\frac{2}{5}\delta + \frac{8}{5}(1 - 2\theta)\right),\ t_B^F = b\bar{K}\left(-\frac{1}{5}\delta + \frac{6}{5}(1 - 2\theta)\right), \\ W_A^L &= \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{20}(\delta + 8 - 6\theta) + \frac{b\bar{K}^2}{20}(44\theta^2 - 64\theta + 16), \\ W_B^F &= \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{100}(3\delta - 36 + 22\theta) + \frac{b\bar{K}^2}{25}(83\theta^2 - 108\theta + 27). \end{aligned} \tag{2}$$

[3]Note that the total supply of capital is $\bar{K}$ so when $\theta = 1/2$ residents in both regions own together the total stock of capital.

For G^B (small region's leadership),

$$t_A^F = b\bar{K}\left(\frac{1}{5}\delta + \frac{6}{5}(1-2\theta)\right), \; t_B^L = b\bar{K}\left(-\frac{2}{5}\delta + \frac{8}{5}(1-2\theta)\right),$$
$$W_A^F = \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{100}(3\delta + 36 - 22\theta) + \frac{b\bar{K}^2}{25}(83\theta^2 - 108\theta + 27),$$
$$W_B^L = \frac{1}{2}\bar{K}\theta\Omega + \frac{\delta b\bar{K}^2}{20}(\delta - 8 + 6\theta) + \frac{b\bar{K}^2}{20}(44\theta^2 - 64\theta + 16). \tag{3}$$

The timing game includes a pre-play stage where the regions decide whether to move *Early* or *Late*. If both regions choose to move *Early* or *Late*, the induced tax competition is G^N. If one region i chooses *Early* and the other region j chooses *Late*, the tax competition is a sequential game G^i ($i = A$ or B), and ends up with the Stackelberg-equilibrium welfare levels (W_i^L, W_j^F).

It is easy to check that $W_i^L - W_i^N > 0$ ($i = A,\ B$): if the other region chooses *Late*, then the Stackelberg leader, being able to choose (t_A^N, t_B^N) along the follower's reaction function, is better off by choosing *Early*.[4] So the following two conditions are crucial for the determination of the equilibrium timing (see Appendix A):

Lemma 1 *(second-mover incentives):*
$W_A^F \gtrless W_A^N \iff \theta \lesseqgtr \frac{1}{2} - \frac{\delta}{8} \equiv \theta^a$. $W_B^F \gtrless W_B^N \iff \theta \lesseqgtr \frac{1}{2} - \frac{9\delta}{88} \equiv \theta^b$. *Since* $\frac{9}{88} < \frac{1}{8}$, *so* $\theta^a < \theta^b$.

The equilibrium timing is characterized as follows. First, for $\theta \in [0, \theta^a]$, both regions have the second-mover incentive. Here, (*Early, Late*) and (*Late, Early*) are the equilibrium timing: this is an extension of HN (2015) to $\theta > 0$. Second, for $\theta \in (\theta^a, \theta^b)$, the large region does not have the second-mover incentive, so playing *Early* becomes the strictly dominant strategy for region A. Region B maintains the second-mover incentive, so that (*Early, Late*) is the only equilibrium. Third, for $\theta > \theta^b$, playing *Early* is the strictly dominant strategy for both regions, so (*Early, Early*) is the equilibrium timing: this is an extension of Ogawa (2013) to $\theta < 1/2$.

We next discuss the equilibrium selection for $\theta \in [0, \theta^a]$. We use Harsanyi and Selten's (1988) risk-dominance criterion. The equilibrium (*Early, Late*) risk-dominates (*Late, Early*) if and only if:

$$\Pi \equiv (W_A^L - W_A^N)(W_B^F - W_B^N) - (W_A^F - W_A^N)(W_B^L - W_B^N) > 0. \tag{4}$$

[4] The Stackelberg leader is strictly better off than the simultaneous move: $W_A^L - W_A^N = b\bar{K}^2(\delta + 4 - 8\theta)^2/320 > 0$, $W_B^L - W_B^N = b\bar{K}^2(-\delta + 4 - 8\theta)^2/320 > 0$.

From the values presented above, the derivations product is:

$$\Pi = -\frac{3}{4000}b^2\bar{K}^4\delta(1-2\theta)(\delta+2\sqrt{6}(1-2\theta))(\delta-2\sqrt{6}(1-2\theta)),$$

so that $\Pi \gtrless 0 \iff \theta \lessgtr \frac{1}{2} - \frac{\delta\sqrt{6}}{24}$. As $\sqrt{6}/24 < 1/8$, so $\Pi > 0$ for all $\theta \in [0, \theta^a]$. Moreover, (*Early, Late*) Pareto dominates (*Late, Early*), if $\theta > \max\left\{0,\ \frac{1}{2} - \frac{\sqrt{15}+1}{28}\delta\right\} \equiv \theta^c$ (see Appendix B). This is an extension of HN (2015, Proposition 1 (ii)).[5]

Proposition 1 *(the ownership effect) Under asymmetry in market power ($\delta > 0$) and symmetry in capital ownership ($\theta \in [0, 1/2]$) there exist $0 \le \theta^c < \theta^a < \theta^b < 1/2$ such that :*

(i) For $\theta \in [0, \theta^a]$, the SPEs are (Early, Late) and (Late, Early). Moving sequentially instead of simultaneously is Pareto-superior. The leadership by the large region risk-dominates. For $\theta \in (\theta^c, \theta^a]$, the leadership by the large region is Pareto-superior.

(ii) For $\theta \in (\theta^a, \theta^b)$, the unique SPE is (Early, Late). Only the leadership by the large region, which is Pareto-superior to the simultaneous move, prevails.

(iii) For $\theta \in (\theta^b, 1/2]$, the simultaneous-move is the unique SPE outcome.[6]

In short, the leadership by the large region is risk-dominant when θ is small, and the simultaneous move outcome prevails when θ is large. For $\theta \in [0, \theta^a)$, most capital owners are non residents, both regions are tax importers ($K_i > \theta\bar{K}$), so they seek to tax as much income as possible from capital owners. Evaluated at the equilibrium tax rates, $\partial W_i(t_i^N, t_j^N)/\partial t_j > 0$ ($i = A, B,\ j \neq i$): there is a positive spillover. There are two Stackelberg outcomes but the leadership by the large region is risk dominant and it becomes even Pareto dominant for $\theta^c < \theta \le \theta^a$. When $\theta > \theta^a$, the small region suffers from negative spillover ($\partial W_B(t_A^N, t_B^N)/\partial t_A < 0$) so region B, when it leads, drives the equilibrium taxes below the Nash equilibrium ($(t_A^F, t_B^L) < (t_A^N, t_B^N)$) in order to increase the price of capital. As a result, region A, the capital importer, preferred the Nash Game G^N to G^B. Thus leadership by the small region cannot prevail as the equilibrium outcome.

The next proposition follows directly.

[5]Pareto domination in the case of $\theta = 0$ is covered in HN (2015). Indeed for $\delta > \sqrt{15} - 1 \approx 2.872983$, $\theta^c = 0$.

[6]We disregard $\theta = \theta^b$ is the borderline case in which (*Early, Late*) and (*Early, Early*) are the equilibria.

Proposition 2 *(the size effect) Reducing the asymmetry in size reduces the chance that the simultaneous-outcome prevails. In the limit, under symmetry in size ($\delta = 0$) and symmetry in capital ownership ($\theta \in [0, 1/2)$),*[7] *we have that $\theta^a = \theta^b = 1/2$. Therefore, the SPEs are (Early, Late) and (Late, Early) for all $\theta \in [0, 1/2)$. Moving sequentially instead of simultaneously is Pareto-superior.*

Less asymmetry makes the Nash outcome less likely. When asymmetry decreases, under partial ownership, the small region is also a capital importer ($K_B^N > \theta\bar{K}$) and so it wishes to increase tax to lower the price of capital. The Stackelberg outcome is preferable. However for sufficiently high asymmetry, the small region becomes a capital exporter ($K_B^N < \theta\bar{K}$) and so it wishes to tax less by contrast to the large region which is a capital importer ($K_A^N > \theta\bar{K}$). Then the simultaneous outcome is preferable.

3 Conclusion

This paper demonstrates that there exists a critical level of capital ownership such that the endogenous timing of tax competition switches from a Stackelberg outcomes to a Nash outcome. This critical level of capital ownership is strictly less than the full ownership of capital by residents when the regions differs in size. The paper also shows that when the Stackelberg outcome prevails it always involves leadership by the large region. This is an extension of Hindriks and Nishimura (2015) to the presence of partial ownership of capital by the residents. When the regions are symmetric, the Stackelberg outcome always prevails, regardless of ownership of capital by the residents. The result reconciles some opposite results in the literature under the assumption of uniform capital ownership between regions.

Appendix A: Proof of Lemma 1

$W_A^F - W_A^N = -3b\bar{K}^2(8\theta - 4 + \delta)(9\delta - 88\theta + 44)/1600$, with $9\delta - 88\theta + 44 > 0$. So $W_A^F \gtrless W_A^N \iff \theta \lesseqgtr \frac{1}{2} - \frac{\delta}{8} \equiv \theta^a$. Also, $W_B^F - W_B^N = -3b\bar{K}^2(-8\theta + 4 + \delta)(9\delta + 88\theta - 44)/1600$, with $-8\theta + 4 + \delta > 0$. Therefore, $W_B^F \gtrless W_B^N \iff \theta \lesseqgtr \frac{1}{2} - \frac{9\delta}{88} \equiv \theta^b$. *Q.E.D.*

[7] $\delta = 0$ and $\theta = 1/2$ would make $t_i^N = t_i^L = t_i^F = 0$ ($i = A, B$). So here we consider $\theta < 1/2$.

Appendix B: Pareto dominance

$W_A^L - W_A^F = b\bar{K}^2(\delta + (\sqrt{15}+1)(1-2\theta))(\delta - (\sqrt{15}-1)(1-2\theta))/50$, so that $W_A^L > W_A^F \iff \theta > \max\left\{0, \frac{1}{2} - \frac{\sqrt{15}+1}{28}\delta\right\} \equiv \theta^c$. $W_B^F - W_B^L = -b\bar{K}^2(\delta + (\sqrt{15}-1)(1-2\theta))(\delta - (\sqrt{15}+1)(1-2\theta))/50$, so that $W_B^F > W_B^L \iff \theta < \frac{1}{2} - \frac{\sqrt{15}-1}{28}\delta$. $\frac{\sqrt{15}+1}{28} > \frac{1}{8}$ so $\theta^c < \theta^a$, and $\frac{\sqrt{15}-1}{28} < \frac{1}{8}$. Therefore, $W_A^L > W_A^F$ and $W_B^F > W_B^L$ for all $\theta \in (\theta^c, \theta^a]$.

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